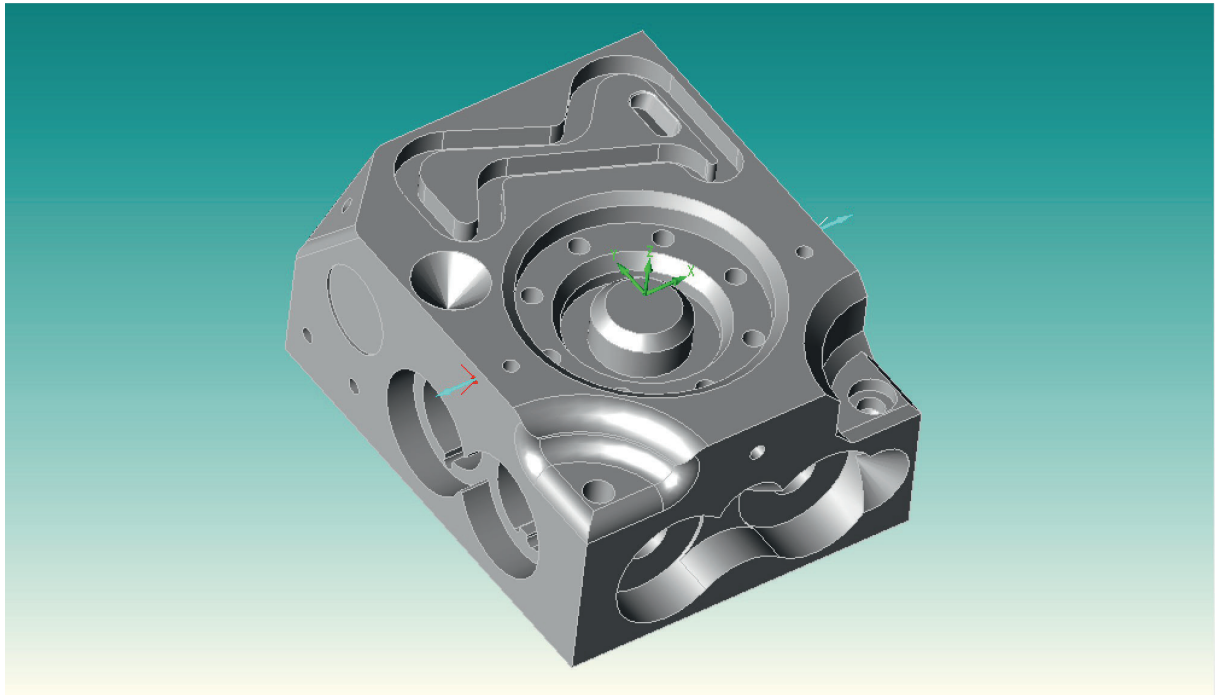


## Further feature measurement and output (CAD)



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## **Further feature measurement and output (CAD)**

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## Contents

1	Further feature measurement and output (CAD).....	6
1.1	Tutorial pre-requisites.....	6
1.2	Tutorial objectives.....	6
2	Introduction.....	7
3	Apply tolerance functions to measured features .....	8
4	Output of measured results .....	11
5	Generation of report from feature grid.....	14
6	Working in polar co-ordinates.....	16
7	Output of measured results in polar co-ordinates .....	18

# **1 Further feature measurement and output (CAD)**

## **1.1 Tutorial pre-requisites**

- The student should have completed, and have a sound knowledge of all 'Alignment' tutorials and 'Further CNC measurement function' tutorials

## **1.2 Tutorial objectives**

- Further exposure to feature measurement using data obtained from a CAD model
- Introduction to the tolerancing and output of measured results
- Introduction to the creation of simple reports
- Introduction to the use of polar co-ordinates for both measurement and output

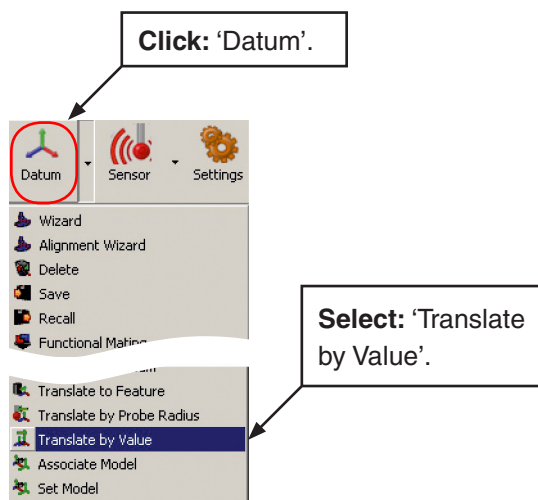
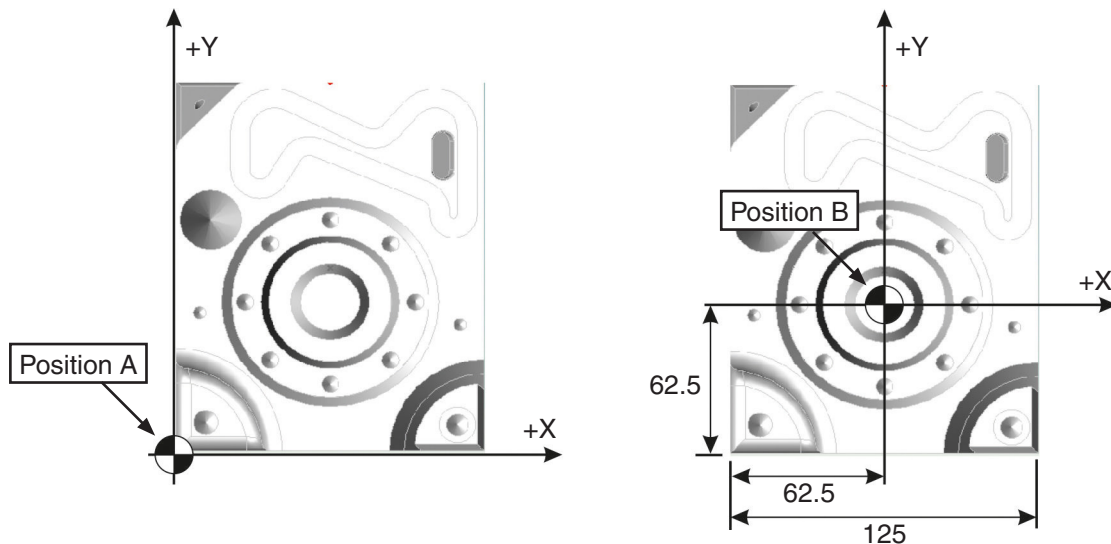
## 2 Introduction

This tutorial will further develop feature measurement skills as well introducing the student to the tolerancing and output of measured results. Additionally, the student will be introduced to the concept of defining feature position by using radial and angular parameters which are particularly useful when features have rotational symmetry about a datum.

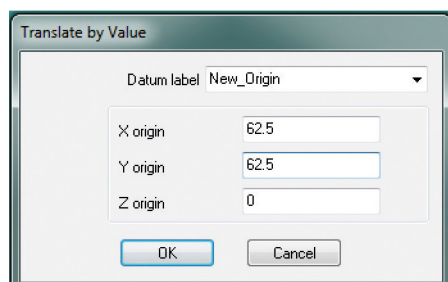
### 3 Apply tolerance functions to measured features

Use the 'Plane, line and point' program to generate the alignment. Ensure that the program is in CNC mode following this alignment. To do this go to 'Settings' select 'Mode' then select 'Program (CNC)'.

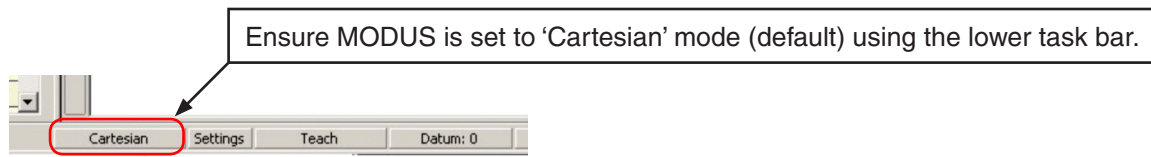
Move / translate origins from position A to position B:



Enter the drawing values:

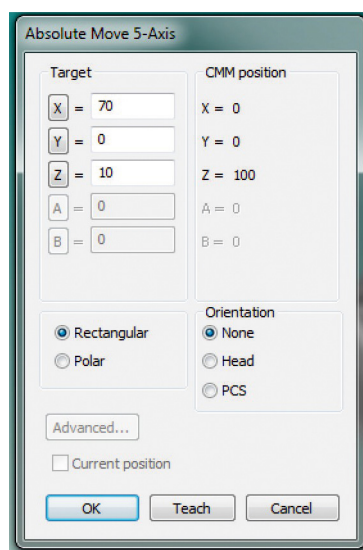


Now measure some points, add tolerances to them and then output the measured results.



**NOTE:** The program will NOT show any new code at this point.

Move the probe to the right hand face of block using an 'Absolute' GOTO move:



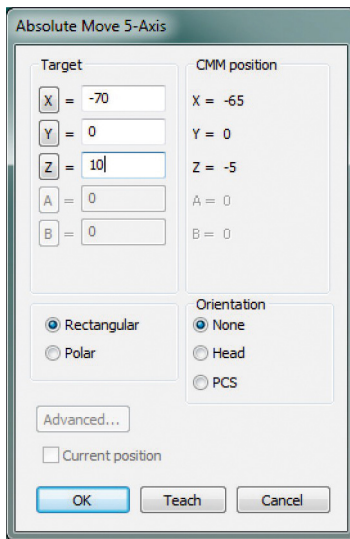
Click on the CAD at the point to be measured and to obtain the point nominal data.

If necessary modify the nominal data to ensure the point is taken at the desired position.

Point	X_PLUS_POINT						
	Actual	Nominal	Low tol	High tol	Deviation	Status	Error
X axis	62.487	62.5			-0.013		
Y axis	0	0			0		
Z axis	-5	-5			0		
I	1	1					
J	0	0					
K	0	0					
Profile point							

**Click:** 'Apply' to complete the measurement process.

Now move the probe to the left hand face of the block using an 'Absolute' GOTO move:



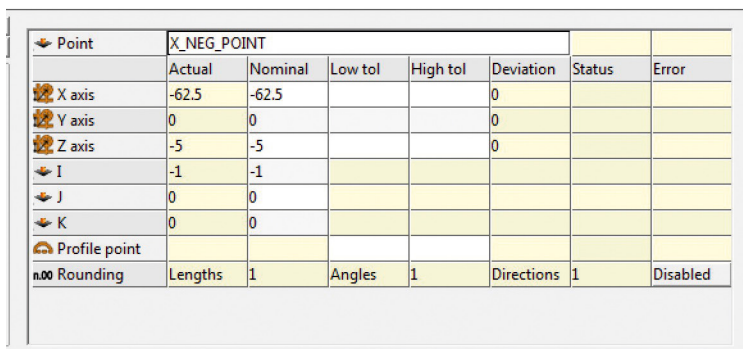
The 'Absolute Move 5-Axis' dialog box is shown. It has two main sections: 'Target' and 'CMM position'. The 'Target' section has input fields for X, Y, Z, A, and B. The 'CMM position' section has corresponding fields for X, Y, Z, A, and B. Below these are radio buttons for 'Rectangular' (selected) and 'Polar'. There is an 'Advanced...' button and a 'Current position' checkbox. At the bottom are 'OK', 'Teach', and 'Cancel' buttons.

Target	CMM position
X = -70	X = -65
Y = 0	Y = 0
Z = 10	Z = -5
A = 0	A = 0
B = 0	B = 0

Orientation: ☒ None, ☐ Head, ☐ PCS

Buttons: OK, Teach, Cancel

Again, click on the CAD at the point to be measured and to obtain the point nominal data. If necessary modify the nominal data to ensure the point is taken at the desired position.

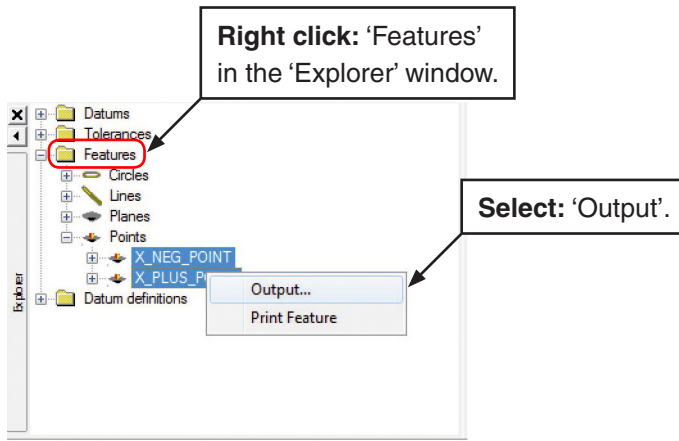


Point	X_NEG_POINT						
	Actual	Nominal	Low tol	High tol	Deviation	Status	Error
X axis	-62.5	-62.5			0		
Y axis	0	0			0		
Z axis	-5	-5			0		
I	-1	-1					
J	0	0					
K	0	0					
Profile point							
n.00 Rounding	Lengths	1	Angles	1	Directions	1	Disabled

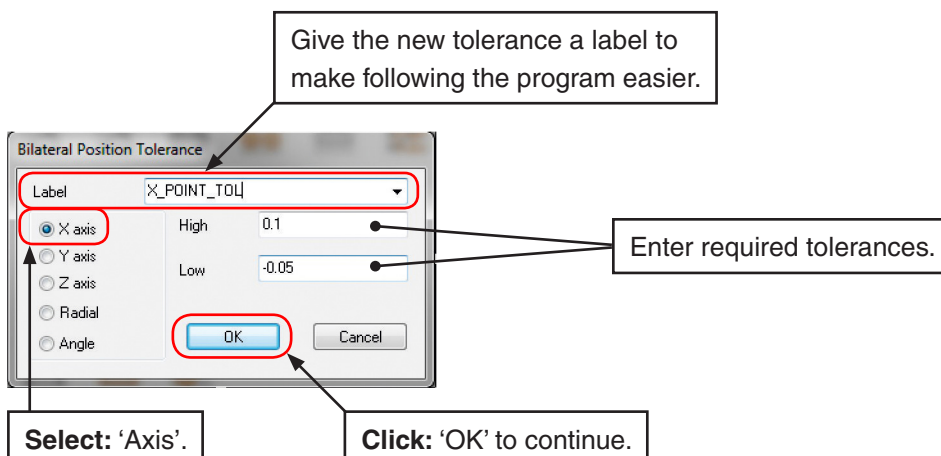
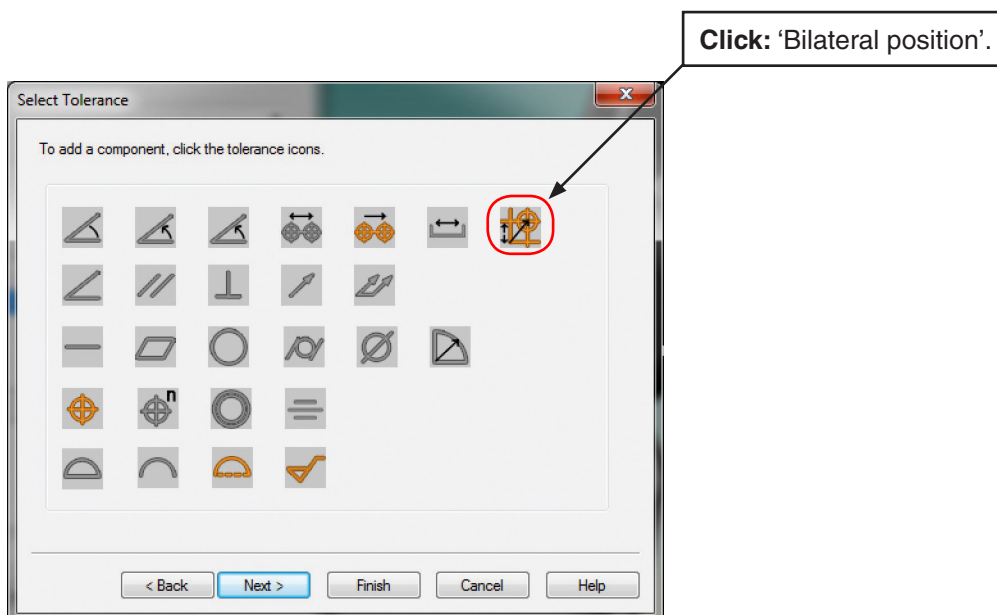
**Click:** 'Apply' to complete the measurement process.

## 4 Output of measured results

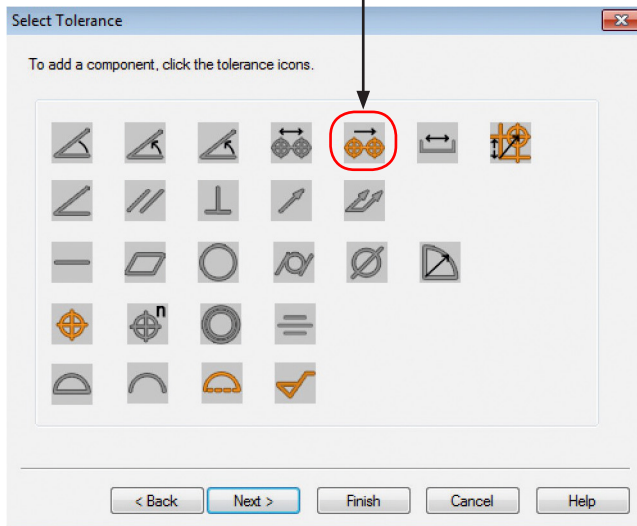
In the 'Explorer' window under 'Features', right mouse click on the points measured and select 'Output'. Next select 'New'.



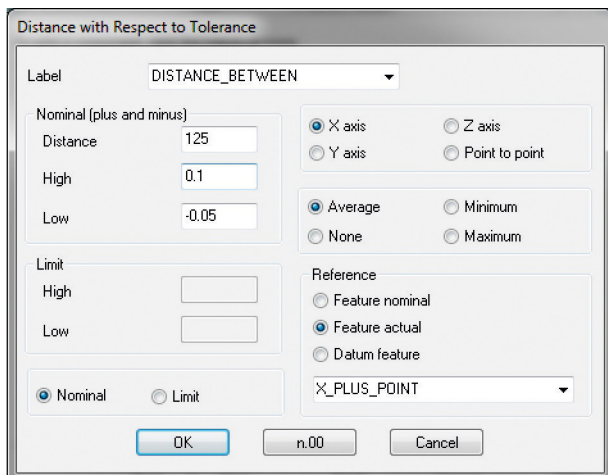
After selecting the measured feature(s) to output click 'New'.



Click: 'New then select 'Distance With Respect To' tolerance'.



Input all details as required including axis then click 'OK' to continue. For further info: Press F1.



Tolerances applied in grid and output window:

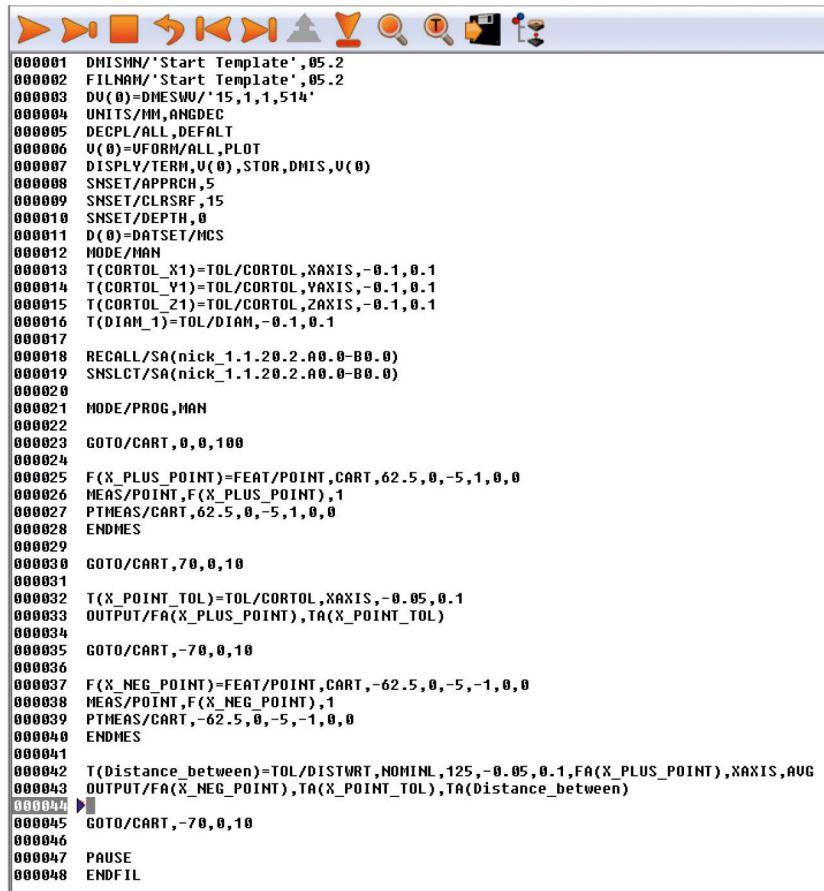
Point	X_NEG_POINT						
	Actual	Nominal	Low tol	High tol	Deviation	Status	Error
X axis	-62.546	-62.5	-0.05	0.1	-0.046	OK	0
Y axis	0	0			0		
Z axis	-5	-5			0		
I	-1	-1					
J	0	0					
K	0	0					
Distance with respect to	124.976	125	-0.05	0.1	-0.024	OK	0
Profile point							

Point: X_PLUS_POINT	62.430	62.500	-0.050	+0.100	-0.070	OK	-0.020
X-axis	-62.546	-62.500	-0.050	+0.100	-0.046	OK	
Y-axis	124.976	125.000	-0.050	+0.100	-0.024	OK	
Length-Xavg							



DMIS code generated for program working in Cartesian:



```

000001 DMISHM/'Start Template',05.2
000002 FILNAM/'Start Template',05.2
000003 DV(0)=DMESWU/'15,1,1,514'
000004 UNITS/MM,ANGDEC
000005 DECPL/ALL,DEFAULT
000006 U(0)=UFORM/ALL,PLOT
000007 DISPLY/TERM,U(0),STOR,DMIS,U(0)
000008 SNSET/APPRCH,5
000009 SNSET/CLSRF,15
000010 SNSET/DEPTH,0
000011 D(0)=DATSET/MCS
000012 MODE/MAN
000013 T(CORTOL_X1)=TOL/CORTOL,XAXIS,-0.1,0.1
000014 T(CORTOL_Y1)=TOL/CORTOL,YAXIS,-0.1,0.1
000015 T(CORTOL_Z1)=TOL/CORTOL,ZAXIS,-0.1,0.1
000016 T(DIAM_1)=TOL/DIAM,-0.1,0.1
000017
000018 RECALL/SA(nick_1.1.20.2.A0.0-00.0)
000019 SNLCT/SA(nick_1.1.20.2.A0.0-00.0)
000020
000021 MODE/PROG,MAN
000022
000023 GOTO/CART,0,0,100
000024
000025 F(X_PLUS_POINT)=FEAT/POINT,CART,62.5,0,-5,1,0,0
000026 MEAS/POINT,F(X_PLUS_POINT),1
000027 PTMEAS/CART,62.5,0,-5,1,0,0
000028 ENDMES
000029
000030 GOTO/CART,70,0,10
000031
000032 T(X_POINT_TOL)=TOL/CORTOL,XAXIS,-0.05,0.1
000033 OUTPUT/FA(X_PLUS_POINT),TA(X_POINT_TOL)
000034
000035 GOTO/CART,-70,0,10
000036
000037 F(X_NEG_POINT)=FEAT/POINT,CART,-62.5,0,-5,-1,0,0
000038 MEAS/POINT,F(X_NEG_POINT),1
000039 PTMEAS/CART,-62.5,0,-5,-1,0,0
000040 ENDMES
000041
000042 T(Distance_between)=TOL/DISTWRT,NOMINL,125,-0.05,0.1,FA(X_PLUS_POINT),XAXIS,AUG
000043 OUTPUT/FA(X_NEG_POINT),TA(X_POINT_TOL),TA(Distance_between)
000044
000045 GOTO/CART,-70,0,10
000046
000047 PAUSE
000048 ENDFIL
  
```

## 5 Generation of report from feature grid

**Prerequisite:** A measured feature must be present in the program which has had tolerances applied.

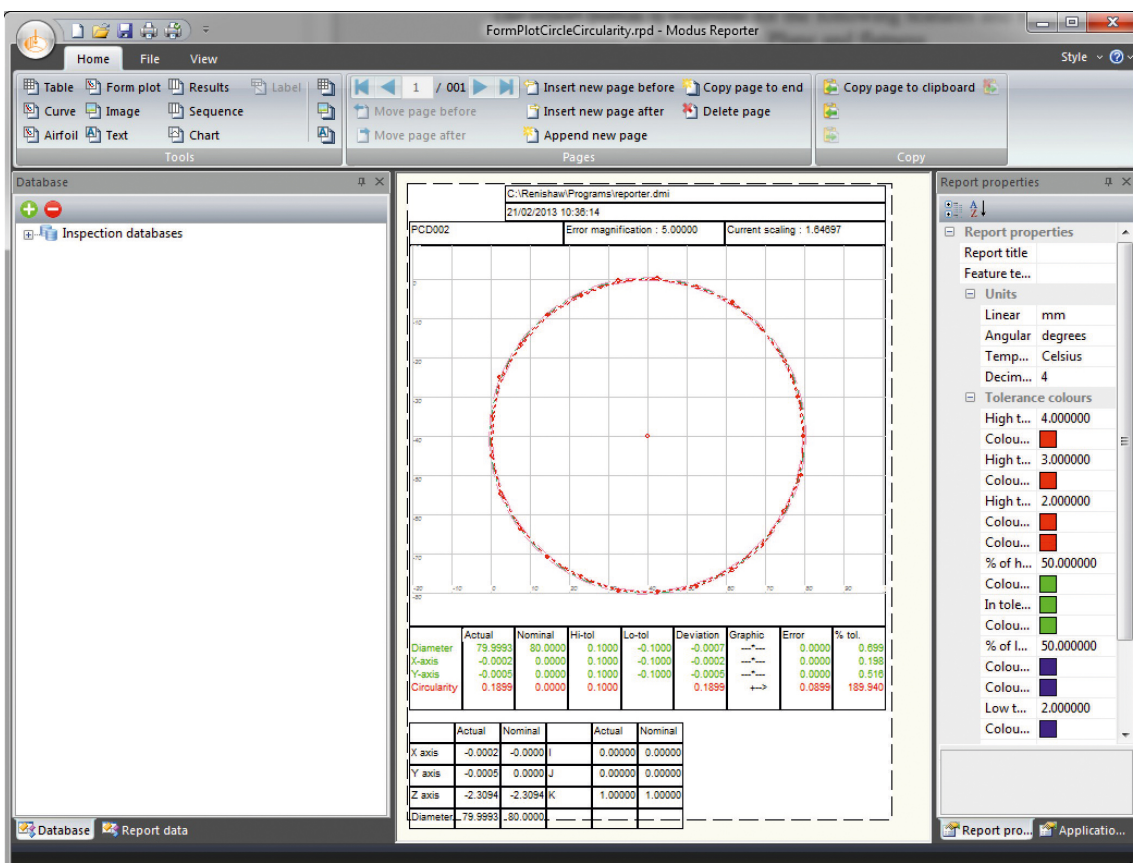
When the report button is available, start 'MODUS reporter' directly from the grid window and display a form plot report appropriate for the feature selected in the grid window.

The report button is available for the following features and form tolerance types:

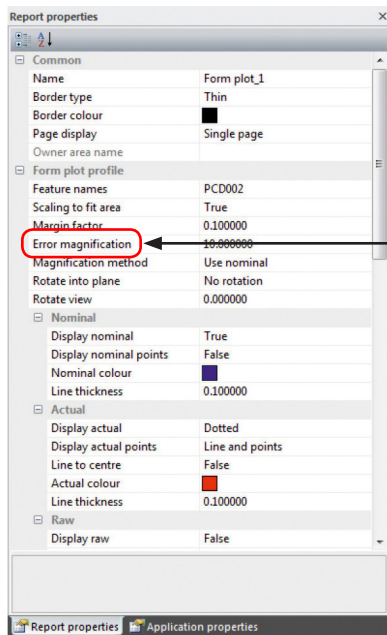
- Plane and flatness
- Line and straightness
- Circle and circularity
- Circle and circular runout
- Surface finish
- Airfoil

**Click:** 'Report' button to open 'MODUS reporter' as displayed below.

Circle	PCD002						Inner	
Report	Actual	Nominal	Low tol	High tol	Deviation	Status	Error	
X axis	-0	0	-0.1	0.1	-0	+++---	0	
Y axis	-0.001	0	-0.1	0.1	-0.001	+++---	0	
Z axis	-2.309	-2.309			0			
I	0	0						
J	0	0						
K	1	1						
Diameter	79.999	80	-0.1	0.1	-0.001	+++---	0	
Circularity	0.19			0.1		+++>	0.09	



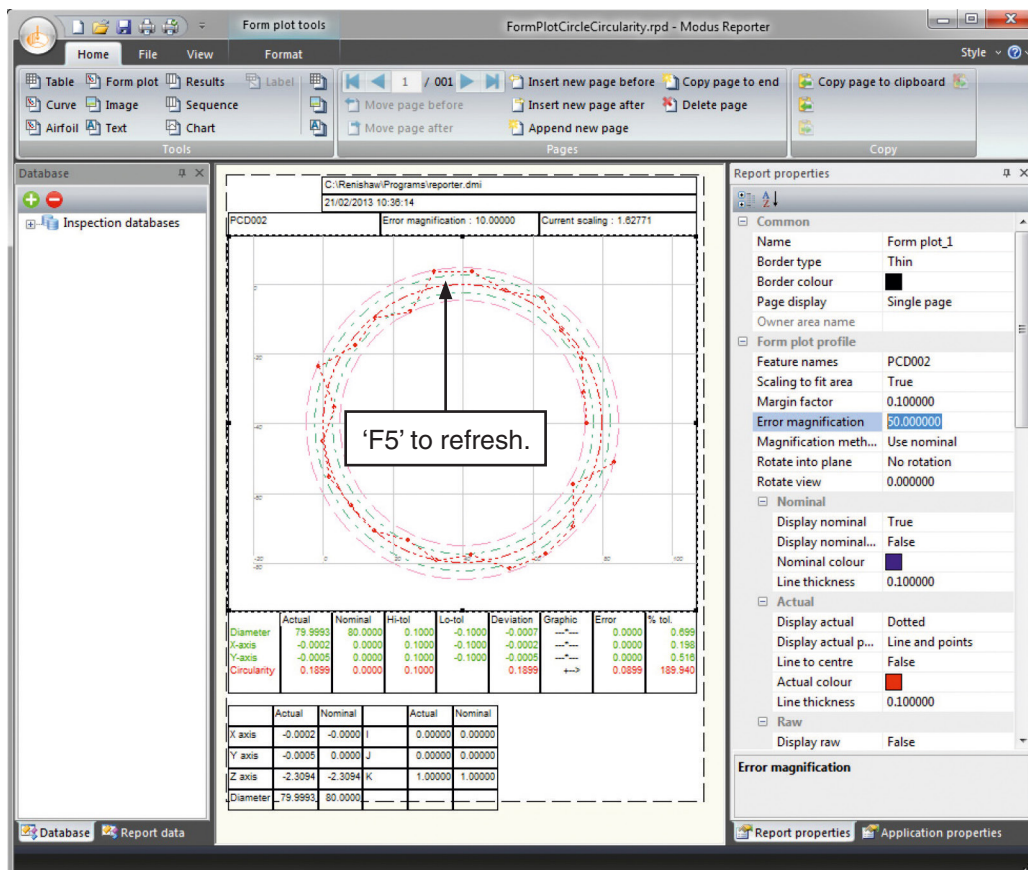
Use the report properties window to view and edit the properties of the selected area of the report.



Select the 'Form Plot' by clicking on it in the report page.

Error magnification has been used as an example. Adjust as required. After properties have been amended press 'F5' to view all amendments made.

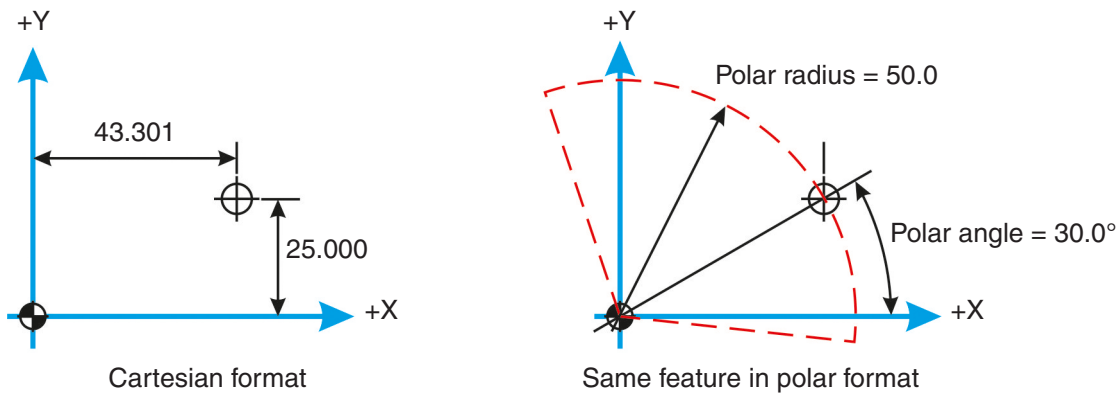
For further details on report properties refer to the 'Reporter' help (F1) or subsequent tutorial.



To print report, click print icon and follow on screen instructions

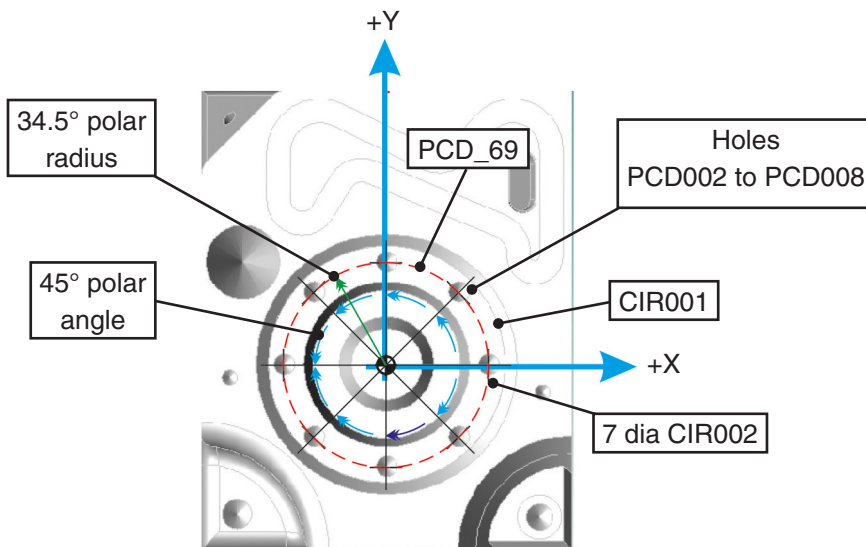
## 6 Working in polar co-ordinates

In some cases when a part is measured, the output dimensions are required in the polar format. This enables angular and radial positions of a feature with respect to the current datum system instead of the default Cartesian (X and Y etc.).



**Remember:** Angles are struck from the major axis of the working plane.

In this part of the tutorial the eight holes shown below will be measured, and then output their position as a polar radius and polar angle.



Prior to measuring the holes carry out a precise alignment of the component as described in previous tutorials.

Switch MODUS into polar mode using the lower task bar. The default condition is Cartesian.



**NOTE:** The program will NOT show any new code at this point.

Move the probe to a position over circle PCD002 and make an 'Absolute' GOTO:

**000033** ▶ GOTO/POL,34.5,45,5

The GOTO statements are now in polar.

The format is 'Radius', 'Angle', 'Height'. Angles will be expressed between 0 to 180 / 0 to -180.

Measure the final seven holes as normal giving each of them a label (PCD002 to PCD008).

Insert GOTO moves to clear the part.

The program code should look something like this:-

GOTO/POL,34.5,-45,5

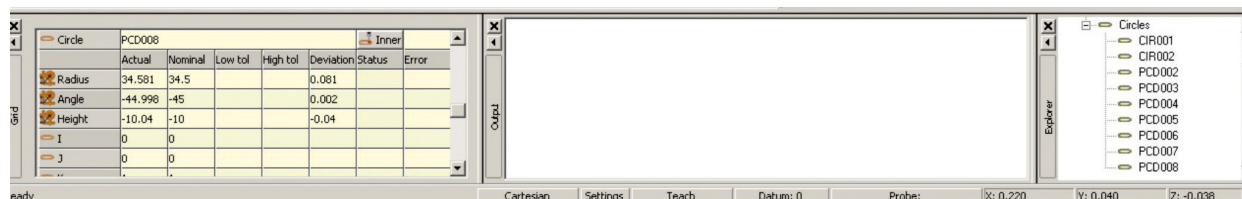
```

$$<MEAS_CIRCLE name = "PCD008">
F(PCD008)=FEAT/CIRCLE,INNER,POL,34.5,-45,-10,0,0,1,7
MEAS/CIRCLE,F(PCD008),4
PTMEAS/POL,34.449,-50.819,-12.092,0.752,0.659,0
PTMEAS/POL,36.364,-49.793,-11.308,0.263,0.965,0
PTMEAS/POL,37.909,-46.258,-11.444,-0.519,0.855,0
PTMEAS/POL,37.981,-44.427,-13.791,-0.78,0.626,0
ENDMES
$$<MEAS_CIRCLE = PCD008>

```

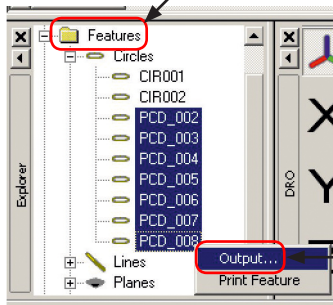
GOTO/POL,34.5,-45,5

After the program has finished the following information should be seen:

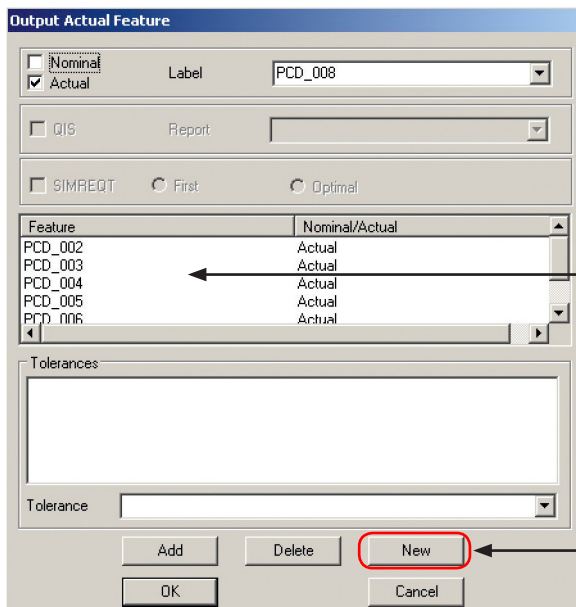


## 7 Output of measured results in polar co-ordinates

Using the 'Explorer' window highlight the 'Features' to output.

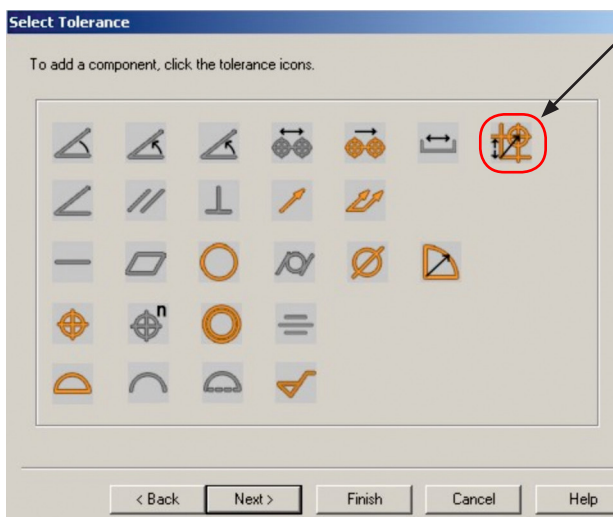


Right mouse click on the features and select 'Output'.



Selected features are placed in this window:

Click: 'New' to continue.



Click: 'Bilateral position'.



Give the new tolerance a label to make following the program easier.

Bilateral Position Tolerance

Label: P\_Rad

High: 0.1

Low: -0.1

☒ X axis

☐ Y axis

☐ Z axis

☒ Radial

☐ Angle

OK Cancel

Enter required tolerances.

Select: 'Radial'.

Click: 'OK' to continue.

Click: 'Bilateral position'.

Select Tolerance

To add a component, click the tolerance icons.

< Back Next > Finish Cancel Help

Give the new tolerance a label to make following the program easier.

Bilateral Position Tolerance

Label: P\_Ang

High: 0.05

Low: -0.05

☐ X axis

☐ Y axis

☐ Z axis

☐ Radial

☒ Angle

OK Cancel

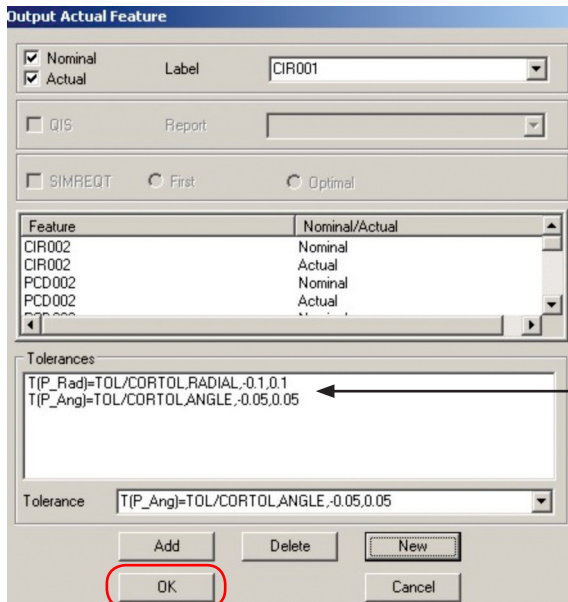
Enter required tolerances.

Select: 'Angle'.

Click: 'OK' and then 'Finish' to complete..

At this point MODUS writes the following code to the program:

$T(P\_Ang)=TOL/CORTOL,ANGLE,-0.05,0.05$



MODUS adds new tolerances to the 'Tolerance' window.

Click: 'OK' to complete tolerance definition

Now MODUS writes ALL the previously selected features along with the associated tolerances to the program and also populates the output window with the results:

000130 \$ \$ =====

000131

000132 T(P\_Rad)=TOL/CORTOL,RADIAL,-0.1,0.1

000133 T(P\_Ang)=TOL/CORTOL,ANGLE,-0.05,0.05

000134 OUTPUT/F(CIR002),T(P\_Rad),T(P\_Ang)

000135 OUTPUT/F(CIR002),TA(P\_Rad),TA(P\_Ang)

000136 OUTPUT/F(PCD002),T(P\_Rad),T(P\_Ang)

000137 OUTPUT/F(PCD002),TA(P\_Rad),TA(P\_Ang)

000138 OUTPUT/F(PCD003),T(P\_Rad),T(P\_Ang)

000139 OUTPUT/F(PCD003),TA(P\_Rad),TA(P\_Ang)

000140 OUTPUT/F(PCD004),T(P\_Rad),T(P\_Ang)

000141 OUTPUT/F(PCD004),TA(P\_Rad),TA(P\_Ang)

000142 OUTPUT/F(PCD005),T(P\_Rad),T(P\_Ang)

000143 OUTPUT/F(PCD005),TA(P\_Rad),TA(P\_Ang)

000144 OUTPUT/F(PCD006),T(P\_Rad),T(P\_Ang)

000145 OUTPUT/F(PCD006),TA(P\_Rad),TA(P\_Ang)

000146 OUTPUT/F(PCD007),T(P\_Rad),T(P\_Ang)

000147 OUTPUT/F(PCD007),TA(P\_Rad),TA(P\_Ang)

000148 OUTPUT/F(PCD008),T(P\_Rad),T(P\_Ang)

000149 OUTPUT/F(PCD008),TA(P\_Rad),TA(P\_Ang)

000150

000151

Circle	PCD008	Actual	Nominal	Low tol	High tol	Deviation	Status	Error
Radius		34.532	34.5	-0.1	0.1	0.032	+	0
Angle		-44.876	-45	-0.05	0.05	0.124	+	0.074
Height		-9.997	-10			0.003		
I		0	0					
J		0	0					
K		1	1					
Diameter		6.794	7			-0.206		

Circle	PCD006	XY-radius	XY-angle	Actual	Nominal	Low tol	High tol	Deviation	Status	Error
Circle:PCD006				34.431	34.500	-0.100	+0.100	-0.069	+	
				-135.052	-135.000	-0.050	+0.050	-0.052	+	
Circle:PCD007				34.596	34.500	-0.100	+0.100	0.096	+	
				-89.887	-90.000	-0.050	+0.050	0.113	+	
Circle:PCD008				34.532	34.500	-0.100	+0.100	0.032	+	
				-44.876	-45.000	-0.050	+0.050	0.124	+	



Below is an example of the automated report generated in MODUS.

### REPORT IN RTF FORMAT

05-Jan-2011 14:14			Start Template			Page 1	
(mm)	ACTUAL	NOMINAL	LO-TOL	HI-TOL	DEVIATION	GRAPHIC	ERROR
Datum Diameter							
Circle:CIR001							
Diameter	79.996	80.000	-0.025	+0.025	-0.004	---*---	
8 Holes Equispaced on 69.0 PCD							
Circle:CIR002							
XY-radius	34.551	34.500	-0.100	+0.100	0.051	---+*--	
XY-angle	0.000	0.000	-0.500	+0.500	0.000	---*---	
Circle:PCD002							
XY-radius	34.520	34.500	-0.100	+0.100	0.020	---+*--	
XY-angle	45.006	45.000	-0.500	+0.500	0.006	---*---	
Circle:PCD003							
XY-radius	34.507	34.500	-0.100	+0.100	0.007	---*---	
XY-angle	89.896	90.000	-0.500	+0.500	-0.104	--*+---	
Circle:PCD004							
XY-radius	34.364	34.500	-0.100	+0.100	-0.136	<---+---	-0.036
XY-angle	135.079	135.000	-0.500	+0.500	0.079	---*---	
Circle:PCD005							
XY-radius	34.558	34.500	-0.100	+0.100	0.058	---+*--	
XY-angle	-180.105	-180.000	-0.500	+0.500	-0.105	--*+---	
Circle:PCD006							
XY-radius	34.439	34.500	-0.100	+0.100	-0.061	-*--+---	
XY-angle	-135.084	-135.000	-0.500	+0.500	-0.084	--*+---	
Circle:PCD007							
XY-radius	34.448	34.500	-0.100	+0.100	-0.052	-*--+---	
XY-angle	-89.890	-90.000	-0.500	+0.500	0.110	---+*--	
Circle:PCD008							
XY-radius	34.527	34.500	-0.100	+0.100	0.027	---+*--	
XY-angle	-45.052	-45.000	-0.500	+0.500	-0.052	---*---	
PCD of 8 Holes Relative To Datum Diameter							
Circle:PCD_69							
X-axis	0.041	0.000	-0.050	+0.050	0.041	---+*--	
Y-axis	0.001	0.000	-0.050	+0.050	0.001	---*---	
Diameter	68.979	69.000	-0.025	+0.025	-0.021	*--+---	
Duration 10 secs			FAIL in:19 out:1			End of Report	

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